OPERATING AND MAINTENANCE MANUAL

TEMPERATURE CONTROLLER TYPE 4

LA MESA, CALIFORNIA

MASTER

ENVIRONMENTAL CONTROL EQUIPMENT FOR RESEARCH AND INDUSTRY

OPERATING AND MAINTENANCE MANUAL

TEMPERATURE CONTROLLER TYPE 4

IN TEMP. CHAMBER MOD. # 2850E
S/N 0-29-16 TAG # 2005445

DELTA DESIGN INC

8000 FLETCHER PARKWAY, LA MESA, CALIF. - TEL (714) 465-4141 - TWX: (910) 322-1343 - CABLE: DELTA

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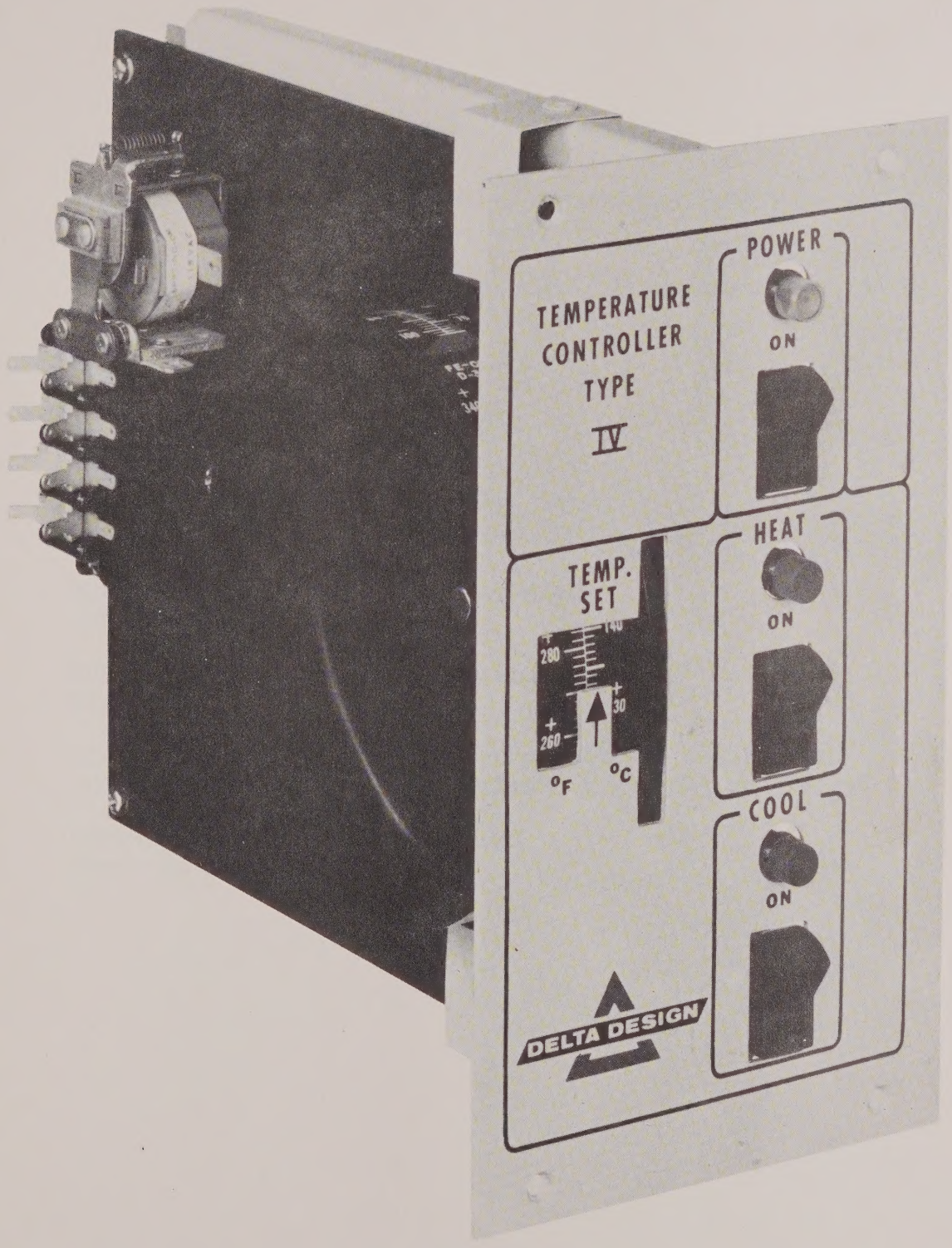

TEMPERATURE
CONTROLLER
TYPE
IV
POWER
ON
HEAT
ON
COOL
ON
TEMP.
SET
280
260
30
°F
°C
DELTA DESIGN

1.0 SPECIFICATIONS:

RANGE:	-75°C to +175°C and -100°F to 350°F (Standard)
SENSOR:	Thermocouple, Iron-Constantan ISA Type J
DIAL ACCURACY:	± 2°C
REGULATING ACCURACY:	± 0.25°C
AMBIENT TEMPERATURE RANGE:	+15°C to +50°C
AMBIENT TEMPERATURE COMPENSATION:	± .05 deg/deg
OVERSHOOT ON START-UP	5°C Maximum
HEAT AND COOL CONTROL METHOD:	Time proportioning on-off, approximately 1 cycle per second
THERMOCOUPLE BREAK PROTECTION:	Standard

2.0 GENERAL DESCRIPTION:

2.1 The Delta Design Type 4 Temperature Controller incorporates a rugged thermocouple sensor combined with the latest advances in integrated circuits and solid state switching.

2.2 The control temperature (set point) is set by means of a drum dial which is calibrated directly in degrees F and C.

2.3 The operating mode, heating or cooling, is selected by rocker switches. The controller can operate in either the heating or cooling mode, and the operator must determine, if the set point calls for heating (usually above ambient) or cooling (usually below ambient).

2.4 Various standard and custom temperature ranges are available. The controller can handle heating loads up to 15 amps, 120 and 240 volts AC, and cooling loads (coolant solenoid valve) up to 2.5 amps, 120 volts AC. For 240 volt operation, the controller is equipped with a 240 volt triac and heat sink assembly, which switches the power for the 240 volt heater. The controller electronics and the coolant solenoid valve however must be supplied with 120 volts through an external stepdown (auto-) transformer.

2.5 The controller is equipped with thermocouple break protection. This feature provides instant shutdown of the heater, in case the thermocouple becomes disconnected.

3.0 CIRCUIT DESCRIPTION:

3.1 The Controller circuit consists of the following functional blocks:

A. Power supply

B. THERMOCOUPLE ambient compensator

C. Set point reference circuit

D. Error amplifier

E. Heat-Cool anticipator

F. Start-up overshoot anticipator

G. Heat-Cool error detector

H. Manual heat-or-cool selection

I. Heat and cool power switches

J. Failsafe relay

3.2 POWER SUPPLY:

3.2.1 When 115 VAC $\pm$ 10 volts is applied to terminals 9 and 11 on TB1 and the power switch S1 is closed, this voltage is presented to pins 1 and 2 on transformer T1. The voltage is reduced to 40 VAC and then rectified by diodes CR5-CR8, and filtered by capacitor C14 and resistor R31. Voltage levels; +10, -10, +5 and -5 volts are generated by Zener diodes CR9 to CR-12.

3.3 AMBIENT TEMPERATURE COMPENSATION:

3.3.1 Thermocouple ambient temperature compensation is provided by voltage divider R32 and R9. This circuit also provides thermocouple break protection.

3.4 SET POINT REFERENCE CIRCUIT:

3.4.1 This curcuit consists mainly of set point pot R1, span pot R2, and zero pot R3. It furnishes a

3.4.1 (continued)

reference voltage to one input of the error amplifier. This reference voltage matches the thermocouple for a given temperature setting.

3.5 ERROR AMPLIFIER:

3.5.1 Basically this is a differential input amplifier, the non inverting input is driven by the thermocouple and the inverting input being fed from a millivolt reference supply.

3.6 START-UP OVERSHOOT AND HEAT-COOL ANTICIPATOR:

3.6.1 Negative feedback is provided by Circuit C1, C2, R14 and R15, and circuit C12, R22, R21, and C13. These two circuits prevent set point temperature overshooting and sloppy control at desired temperature, respectively. Capacitor C13 and Resistor R21 determine the cycle rate of the controller. C13 ensures precise control regardless of heat load by blocking the D.C. component of the feedback signal.

3.7 HEAT-COOL ERROR DETECTOR:

3.7.1 This amplifier, Q3, is operated in the saturated mode.

3.7.2 The output of this amplifier is always either at maximum positive, or at maximum negative level.

3.7.3 Positive feed back is provided by circuit C10,R18,R20 and circuit C9 and R19. This insures rapid transition of amplifier output when it is changing levels. Capacitors C4, C5, C6, C7, C11 and Resistor 16, act as filters to improve the amplifier's noise immunity.

3.8 MANUAL HEAT-OR COOL SELECTION:

3.8.1 When the controller is at null condition (at temperature), the heat and cool reed relays K1 and K2 are alternately energizing. To prevent the chamber from oscillating between heat and cool, the off contacts of the heat switch S2 are in series with the cool relay contacts, and the off contacts of the cool switch S3 are in series with the heat relay contacts. This means, when the controller is operated in the heat mode, the heat switch is on and the cool switch must be off. The inverse is true when cool mode operation is desired.

3.9 HEAT AND COOL POWER SWITCHES:

3.9.1 The aforementioned relay contacts key triac gate circuits, which in turn control the heater load and coolant valve. This type of switching insures low electrical noise generation.

3.10 FAIL SAFE RELAY:

3.10.1 The fail safe relay provides a means for disconnecting the heater in case of controller failure. On 240 volt versions, this relay is not part of the controller package.

4.0 TROUBLE SHOOTING:

4.1 Because most of the components in the Type 4 Controller are serving more than one function it is difficult to assign a malfunction to a specific component.

4.1.1 However, if the technician systematically follows the steps listed below in trouble shooting; no problem, regardless how severe, should require more than a few minutes to locate and repair.

4.1.2 One word of caution:before installing jumpers and/ or equipment probes the power should be turned off.

4.2 EQUIPMENT REQUIRED:

1. Oscilloscope (Not mandatory for most problems).

2. Microvolt Meter

3. Volt Ohm Meter (Such as Simpson No. 260).

4.3 Remove controller from chamber leaving power harness intact.

4.4 Disconnect thermocouple leads from terminals 2 and 3 on TB1 (15 pin terminal block located on Control Printed Circuit Board), and jumper terminal 2 to terminal 3.

4.5 Check voltage input of transformer(T1 should be 115V $\pm$ 10%.)

4.6 Check voltage output of transformer T1(40 VAC.)

4.7 Check voltage across capacitor C14 (30 VDC with 1 volt ripple P.-P.)

4.8 Check voltage across Zener diode CR9 and CR10 (10 volts in respect to common).

4.9 Install shorting jumpers across C1-C2 and C12.

4.10 With the aid of a microvolt meter, measure the voltage span at pin 11 on Q1. When temperture set dial is rotated from high limit to low limit the total range should cover approximately 13 millivolts on -75 - +175^{o}C Controllers and approximately 20.5 millivolts on -75 - +315^{o}C Controllers.

4.11 Adjust controller set point dial so that output of amplifier Q1 (pin 3) is at 0 volts in respect to common (null).

4.12 Change set point dial 2°C and observe voltage change at output, should be 1.50 volts.

4.13 Again adjust set point dial for null at output of Q1.

4.14 While observing the output of Q3 (pin 3) rotate set point dial slowly 1° either side of null setting. Output should never stop at any voltage other than the positive or negative limits +7.5 volts and -7.5 volts respectively.

4.15 Adjust set point dial so that output of Q1 is at null.

4.16 Remove jumper across C1 and C2 and rotate set point dial 20° higher than null. Voltage at output should increase to positive limit then after a few seconds should drift back to about + 4.0 volts. (Start-up anticipation).

4.17 Repeat setps 14 and 15 only rotate 20° lower than null.

4.18 With the controller at null remove the jumper across C12 and observe the output of Q2, the output should cycle between the positive and negative limits.

4.19 At this time verify that with the cool switch off and heat switch on the heat light turns on/off.

4.20 With the heat switch off and the cool switch on that the cool light turns on and off.

NOTE: Do not replace integrated circuits Q1 and Q3 unless they are proven to be bad. If their output state does not change, when their inputs are changed $\pm$ 1 volt relative to each other, then they are bad. Carefully unsolder without damaging board. Replacement of Q1 requires recalibration of zero. Span need not be recalibrated. Replacement of Q3 requires no recalibration.

5.0 CALIBRATION PROCEDURE: FOR -100°- + 350°F CONTROLLER

5.1 Adjust drum dial so that the index tab of the panel lines up between the ends of the scale decal when the drum is turned to either end stop.

5.2 Connect shorting jumpers across C1-C2, and C12 and connect meter as shown (Simpson No. 250 or 260).

5.3 Connect shorting jumper between terminals 2 and 3.

5.4 Apply 115 VAC power to terminals 9 and 11.

5.5 Turn power on, cool on, and heat off.

5.6 Set drum dial to +55°C.

5.7 Adjust zero pot (R3 - Plastic Multiturn) until meter reads zero.

5.8 Feed 6.54 millivolt into terminals 2 (+) and 3 (-).

5.9 Set drum dial to +175°C and adjust span pot (R2 - Metal single turn) until meter reads zero.

5.10 Reconnect a shorting jumper to terminals 2 and 3, and set drum dial to room abient temperature (as measured with a precision mercury thermometer near terminals 2 and 3).

5.11 Re-adjust zero pot until meter again reads zero.

5.12 Remove shorting jumpers.

5.13 CALIBRATION PROCEDURE: FOR -100° - +600°F CONTROLLER

5.14 Adjust drum dial so that the index tab of the panel lines up between the ends of the scale decal when the drum is turned to either end stop.

5.15 Connect shorting jumpers across C1-C2, and C12 and connect meter as shown (Simpson No. 250 or 260).

5.16 Connect shorting jumper between terminals 2 and 3.

5.17 Apply 115 VAC power to terminals 9 and 11.

5.18 Turn power on, cool on, and heat off.

5.19 Set drum dial to 264°F.

5.20 Adjust zero pot (R3-plastic multiturn) until meter reads zero

5.21 Feed 10.33 millivolt into terminals 2 (+) and 3 (-).

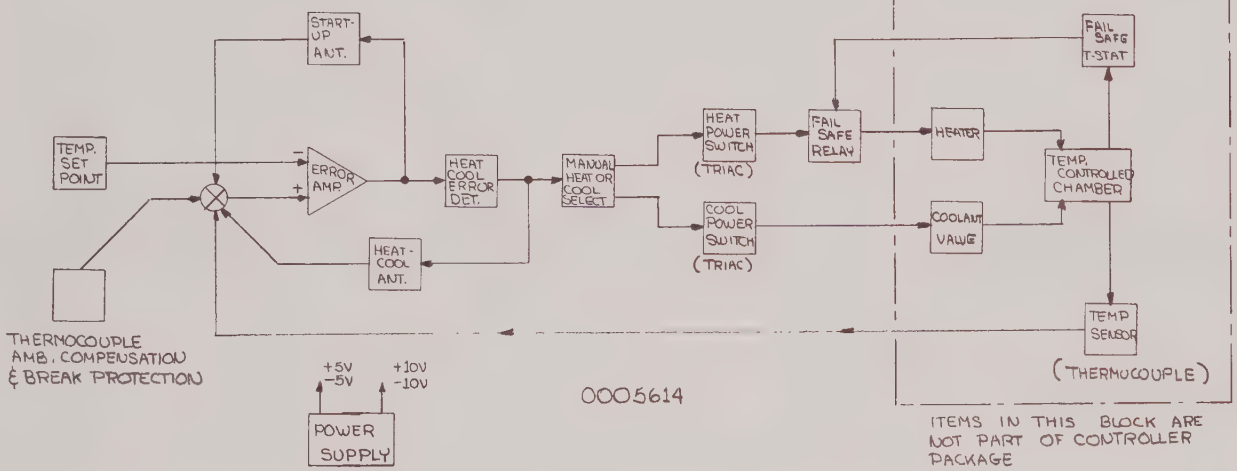
5.22 Set drum dial to 600°F and adjust span pot (R2 - metal single turn) until meter reads zero.

5.23 Re-connect a shorting jumper to terminals 2 and 3, and set drum dial to room ambient temperature (as measured with a precision mercury thermometer near terminals 2 and 3).

5.24 Re-adjust zero pot until meter again reads zero.

5.25 Remove shorting jumpers.

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED



REDUCE TO 8.5

REDUCE TO 11.0

QTY REQ'D	NOMENCLATURE OR DESCRIPTION	CODE IDENT	IDENTIFYING NUMBER	SPECIFICATION	MATERIAL OR NOTE	ITEM NO

NEXT ASSY.	USED ON	SERIAL NOS	DATE EFF	DWG. REV LTR
APPLICATION		EFFECTIVITY		

UNLESS OTHERWISE SPECIFIED DIMENSION ARE IN INCHES
TOLERANCES ON
FRACTIONS ± 1/64 DECIMALS .XX ± .010 .XXX ± .005 ANGLES ± ½

MATERIAL

FINISH

	BY	DATE
DESIGN	BHR	12/13/68
DRAFTED		12/13/68
CHECKED	BHR	12/13/68
APPROV		

PART NO

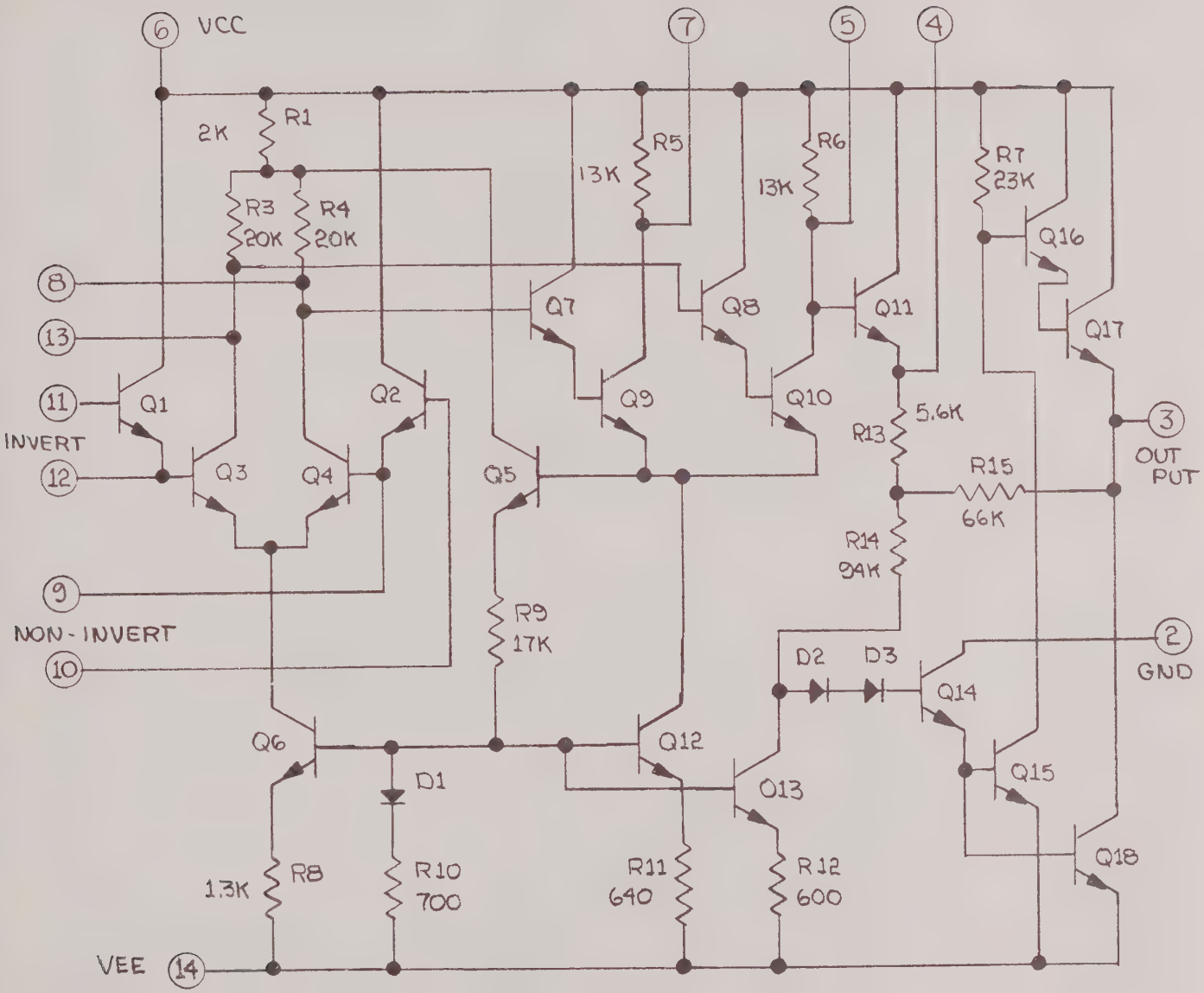
DELTA DESIGN INC.
8000 FLETCHER PKWY
LA MESA, CALIF 92041
TEL. A/C (714) 465-4141

TITLE: FUNCTIONAL BLOCK DIAGRAM TYPE IV CONTROLLER

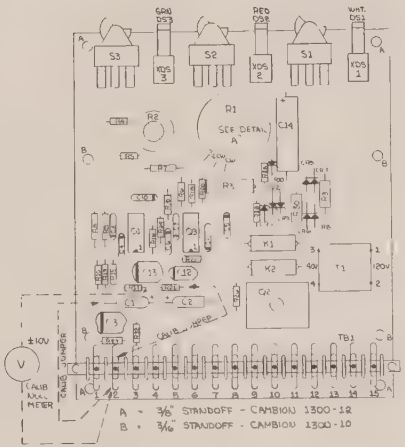
SIZE	CODE IDENT. NO	DRAWING NO	REV LTR
C		0005614	

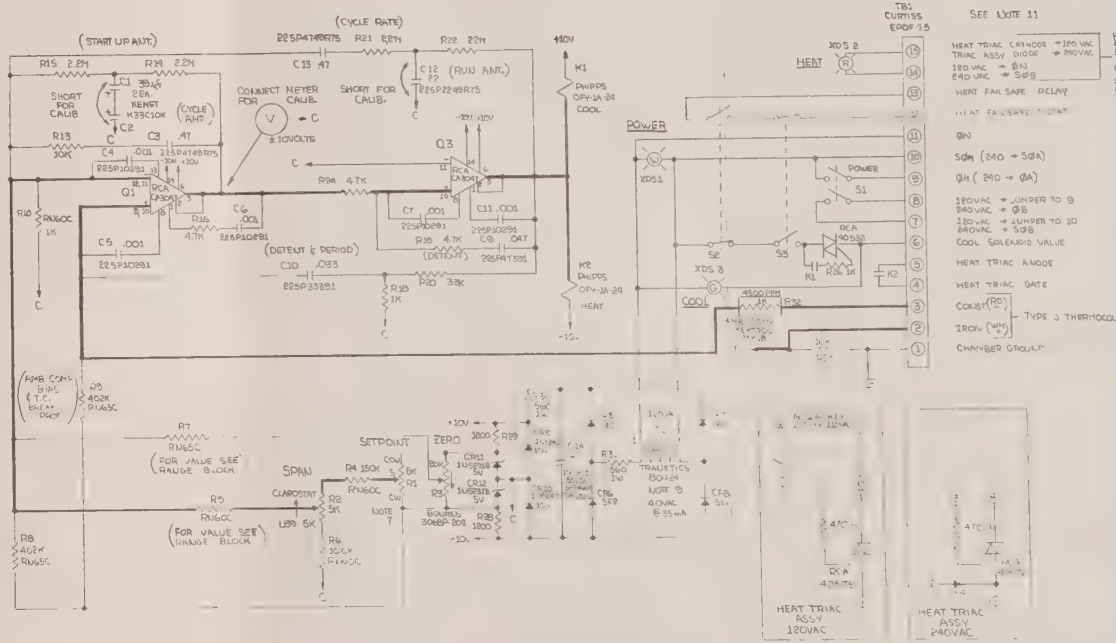
SCALE 15 : 11 SHEET 1 OF 1

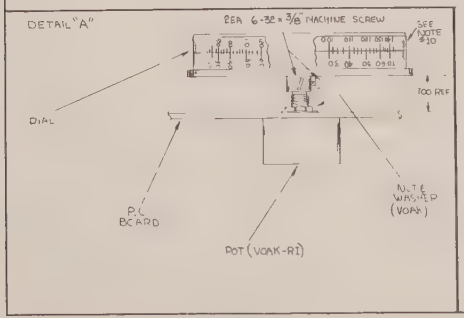
NOTES:



SCHEMATIC DIAGRAM OF R.C.A
OPERATIONAL AMPLIFIER CA3047





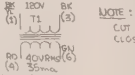


RANGE RESISTORS.

PART	-100° - +350°F		-100° - +600°F	
	VERT.	HORIZ	VERT	HORIZ.
RT	604K	604K	42.2K	42.2K
R5	365K	365K	20.0K	20.0K
DIAL, DIAL	D303131	D303130	D1605548	D1605547

NOTES:

1. ALL SWITCHES: STACKPOLE RS 50FB PC-80
2. ALL LAMPS: DRAKE 30081 BI-PIN 120V
3. ALL LAMP SOCKETS: DRAKE 4428-010 PC LAMPHOLDER
4. LAMP FILTERS: AMP-HERSEAL 3B13/44 R3(RED), G1(GREEN), & W1(WHITE)
5. ALL RESISTORS: 1/8W 5% CARBON COMP. UNLESS OTHERWISE SPECIFIED
6. ALL TYPE 825P CAPACITORS ARE SPRAGUE
7. SETPOINT POTENTIOMETER: VOAK R1, 1½" SINGLE TURN 5K ±3%, .3% LIN 350° ELECT ROT. 360° MECH ROT.
8. ALL DIODES MARKED SEE ARE SEMTECH, SILICON 1AMP, 200PIV
9. FOR APPLICATIONS USING TRIAD F84X (IN PLACE) OF TRANSTECTORS 60424



NOTE: CUT OFF UNUSED LEADS CLOSE TO WINDING BODY

10. APPLY SCALE FLUSH AGAINST FLANGE OF DRUM. FOR DELTA PT NUMBER SEE RANGE BLOCK

TOLERANCES UNLESS SPEC: .XX ± .02 (.5), .XXX ± .010 FRACTIONS ± 1/32, ANGLES ± 1/2°, MACHINE FINISH 125 RMS, PRESSES TO BE FOR .XX PARTS, STAMPINGS .060 THICK OR LESS, .XXX = .005, SURFACE OF .XX IN INCHES AT .28 EXTEND, 2A PLATING UNLESS SPECIFIED, DO DISTURB A, FOCUS 0.0 MAX DO NOT SCALE

DESIGN | DRAFTED | CHECKED | APPROV | PROD APP | MODEL | PART NO | DRAWING NO | REV

DELTA DESIGN INC.
8000 FLETCHER PKWY
LA MESA, CALIF.
TEL 714 465-9401

SCHEMATIC TYPE 4 CONTROLLER

D00561

PARTS LIST

DWG. NO. _____

TITLE CONTROLLER P.C. BOARD TYPE THROUGH

SHT. 1 OF 3

DELTA DESIGN, INC. LA MESA, CALIF.

DASH NO.	REF. DES.	NO. REQ.	DESCRIPTION	COM'L. PT. NO.	MF'R.	DELTA PT. NO.
1	C1 C2	2	CAPACITOR 39 uf 10 VDC	K39C10K	KEMET	0703900-010
2	C3 C13	2	CAPACITOR .47 uf	225P4749R75	SPRAGUE	0800006
3	C4, C5 C6	5	CAPACITOR .001 uf	225P10291	SPRAGUE	0800002
	C7, C11					
4	C9	1	CAPACITOR .047 uf	225P47391	SPRAGUE	0800003
5	C10	1	CAPACITOR .033 uf	225P33391	SPRAGUE	0800004
6	C12	1	CAPACITOR .22 uf	225P2249R75	SPRAGUE	0800005
7	C14	1	CAPACITOR 100 uf 50 VDC	TVA-1310	SPRAGUE	0710000-010
8	CR5 CR6	4	DIODE 1A 200 PIV	1N2070		1102070
	CR7 CR8					
9	CR9 CR10	2	DIODE, ZENER 10V	1N5240		1105240
10	CR11 CR12	2	DIODE, ZENER 5V	1N5231B		1115231
11	DS1 DS2	3	LAMP B1-PIN 120 V	30081	DRAKE	1400068
	DS3					
12	K1 K2	2	RELAY, REED 24 VDC	OFY-1A-24	PHIPPS	1400234
13	Q1 Q3	2	INTEGRATED CIRCUIT	CA3047	R.C.A.	1000003
14	Q2	1	TRIAC	40532	R.C.A.	1201541
15	R1	1	POTENTIOMETER, SET PT.			0500012
16	R2	1	POTENTIOMETER 5K	U39-5K	CLAROSTAT	0500031
17	R3	1	POTENTIOMETER 20K	3068P-203	BOURNS	0500039
18	R4	1	RESISTOR 1% 150K OHM	RN60C1503F		0400009
19	R5	1	(SEE NOTE 1)			
20	R6	1	RESISTOR 1% 10.0K OHM	RN60CC1002F		0400011
21	R7	1	(SEE NOTE 1)			

PARTS LIST

DWG. NO. _____

TITLE CONTROLLER P.C. BOARD TYPE THROUGH

SHT. 3 OF 3

DELTA DESIGN, INC. LA MESA, CALIF.

DASH NO.	REF. DES.	NO. REQ.	DESCRIPTION	COM'L. PT. NO.	MF'R.	DELTA PT. NO.	
42		1	DRUM DIAL 4" DIA			1400746	
43		1	DECAL DIAL (SEE NOTE 1)				

PARTS LIST

DWG. NO. _____

SHT. 1 OF 1

TITLE 120 VOLT TRIAC ASSEMBLY TYPE THROUGH

DELTA DESIGN, INC. LA MESA, CALIF.

DASH NO.	REF. DES.	NO. REQ.	DESCRIPTION	COM'L. PT. NO.	MF'R.	DELTA PT. NO.
1	K1	1	RELAY	120-1X-115VAC	MILWAUKEE	1400533
2	Q1	1	TRIAC	40575	R.C.A.	1201539
3	PC1	1	PRINTED CIRCUIT BOARD			1300032
4	R1	1	RESISTOR C.C. 1/2W 5%	470 OHM		0347000-500
5	TB1	1	TERMINAL BLOCK	EPQF-4	CURTIS	1400529
6		1	HEAT SINK			1603128

TABLE OF RANGE RESISTORS

1. All controller assemblies with the range -100°F - +350°F.

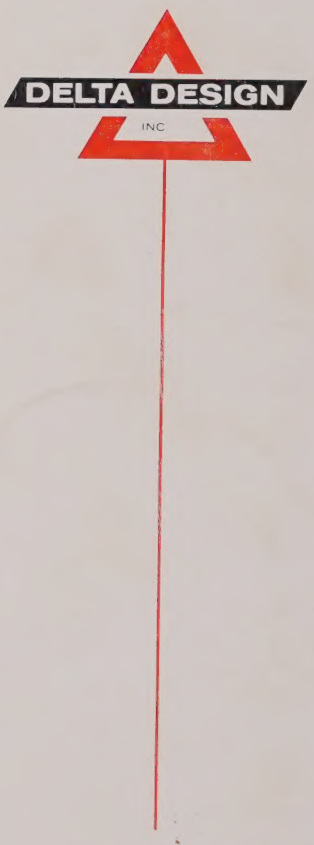
   R5 = Resistor 1% 42.2K Ohm - RN60C4222F = 0400010
   R7 = Resistor 1% 604K Ohm - RN65C6043F = 0400012

   DECAL - Horizontal Applications = D303131
   Vertical Applications = D303130

   All controller assemblies with the range -100°F - 600°F.

   R5 - Resistor 1% 20K Ohm - RN60C2002F = 0400016
   R7 - Resistor 1% 365K Ohm - RN60C3653F = 0400017

   DECAL - Horizontal Applications = D1605547
   Vertical Applications = D1605548



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